IN THE CLAIMS

Please amend the claims as follows:

Claims 1-28 (Canceled).

Claim 29 (Withdrawn): A magnetoresistance effect element, comprising:

a magnetoresistance effect film including,

a nonmagnetic spacer layer, and

first and second ferromagnetic layers separated by the nonmagnetic spacer layer, a magnetization direction of the first ferromagnetic layer being at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the second ferromagnetic layer comprising first and second ferromagnetic films antiferromagnetically coupled to one another and an antiferromagnetically coupling film located between and in contact with the first and second ferromagnetic films for coupling the first and second ferromagnetic films together antiferromagnetically so that their magnetizations are aligned antiparallel with one another and remain antiparallel in the presence of an applied magnetic field, the magnetization of the first ferromagnetic layer freely rotating in a magnetic field signal;

a pair of electrodes coupled to the magnetoresistance effect film and having respective inner edges; and

a pair of longitudinal biasing layers for providing bias magnetic fields to the first ferromagnetic layer in parallel with a longitudinal direction of the first ferromagnetic layer and having respective inner edges, said inner edges of the pair of electrodes being disposed between the inner edges of the pair of longitudinal biasing layers.

Claim 30 (Withdrawn): A magnetoresistance effect element, comprising:

a nonmagnetic spacer layer;

first and second ferromagnetic layers separated by the nonmagnetic spacer layer, the first ferromagnetic layer having a magnetization direction at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the magnetization of the first ferromagnetic layer freely rotating in a magnetic field signal, a magnetoresistance effect-improving layer comprising a plurality of metal films and disposed in contact with the first ferromagnetic layer so that the first ferromagnetic layer is disposed between the nonmagnetic spacer layer and the magnetoresistance effect-improving layer, one of the plurality of metal films disposed in contact with the first ferromagnetic layer contains a metal element of not solid solution with a metal element of the first ferromagnetic layer; and

a nonmagnetic underlayer or a nonmagnetic protecting layer disposed in contact with the magnetoresistance effect-improving layer so that the magnetoresistance effect-improving layer is disposed between the first ferromagnetic layer and the nonmagnetic underlayer or the nonmagnetic protecting layer.

Claim 31 (Currently Amended): A magnetoresistance effect head, comprising:

a magnetoresistance effect element including,

a nonmagnetic spacer layer,

first and second ferromagnetic layers separated by the nonmagnetic spacer layer, the first ferromagnetic layer having a magnetization direction at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the second ferromagnetic layer comprising first and second ferromagnetic films antiferromagnetically coupled to one another and an antiferromagnetically coupling film located between and in contact with the first and second ferromagnetic films for coupling the

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first and second ferromagnetic films together antiferromagnetically so that their magnetizations are aligned antiparallel with one another and remain antiparallel in the presence of an applied magnetic field, the magnetization of the first ferromagnetic layer freely rotating in a magnetic field signal, and

a nonmagnetic conductivity layer disposed in contact with the first ferromagnetic layer so that the first ferromagnetic layer is disposed between the nonmagnetic conductivity layer and the nonmagnetic spacer layer, wherein:

the first ferromagnetic layer has a film thickness between 0.5 nanometers and 4.5 nanometers, and

the nonmagnetic spacer layer, the first ferromagnetic layer, and the second ferromagnetic layer have a film thickness so that a bias point B.P. is in the range of 30-50% when a product of a magnetic saturation M_s and a thickness t of the first ferromagnetic layer is between 2 and 3 nm·T, in which,

B.P. = 50 × (Hshift / Hs) + 50, and

Hshift = -Hin + Hpin ± Hcu,

Hshift is the sum of magnetic fields applied to the first ferromagnetic layer,

Hs is an inclination of a transfer curve, Hin is a coupling magnetic field of the first and second ferromagnetic layers via the nonmagnetic spacer layer,

Hpin is a stray magnetic field from the second ferromagnetic layer to the first ferromagnetic layer, and

Hcu is a magnetic field to be applied to the first ferromagnetic layer.

Claim 32 (Previously Presented): The magnetoresistance effect head of claim 56, wherein an average surface roughness of an upper surface of the lower magnetic gap is smaller than a thickness of the antiferromagnetically coupling film.

Claim 33 (Currently Amended): The magnetoresistance effect head of claim 56, wherein a distance between a center of film thickness of the first ferromagnetic ~~film~~ layer and one of the upper and lower magnetic shields through the nonmagnetic conductivity layer is equal or ~~larger~~ smaller than a distance between the center of film thickness of the first ferromagnetic [[film]] layer and another one of the upper and lower magnetic shields through the second ferromagnetic film.

Claims 34-36 (Canceled).

Claim 37 (Withdrawn): A recording/reproducing magnetic head, comprising:

a substrate;

a lower magnetic shield layer formed on a main surface of the substrate; and

a magnetoresistance effect element formed on the lower magnetic shield layer,

wherein the magnetoresistance effect element includes,

a magnetoresistance effect film having a nonmagnetic spacer layer, and first and second ferromagnetic layers separated by the nonmagnetic spacer layer, a magnetization direction of the first ferromagnetic layer being at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the second ferromagnetic layer comprising first and second ferromagnetic films antiferromagnetically coupled to one another and an antiferromagnetically coupling film located between and in contact with the first and second ferromagnetic films for coupling the first and second ferromagnetic films together antiferromagnetically so that their magnetizations are aligned antiparallel with one another and remain antiparallel in the presence of an applied magnetic field, the magnetization of the first ferromagnetic layer freely rotating in a magnetic field signal;

a pair of electrodes coupled to the magnetoresistance effect film and having respective inner edges; and

a pair of longitudinal biasing layers for providing bias magnetic fields to the first ferromagnetic layer in parallel with a longitudinal direction of the first ferromagnetic layer and having respective inner edges, said inner edges of the pair of electrodes being disposed between the inner edges of the pair of longitudinal biasing layers.

Claim 38 (Withdrawn): A recording/reproducing magnetic head, comprising:

a substrate;

a lower magnetic shield layer formed on a main surface of the substrate; and

a magnetoresistance effect element formed on the lower magnetic shield layer,

wherein the magnetoresistance effect element includes,

a nonmagnetic spacer layer;

first and second ferromagnetic layers separated by the nonmagnetic spacer layer, the first ferromagnetic layer having a magnetization direction at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the magnetization of the first ferromagnetic layer freely rotating in a magnetic field signal, a magnetoresistance effect-improving layer comprising a plurality of metal films and disposed in contact with the first ferromagnetic layer so that the first ferromagnetic layer is disposed between the nonmagnetic spacer layer and the magnetoresistance effect-improving layer, one of the plurality of metal films disposed in contact with the first ferromagnetic layer contains a metal element of not solid solution with a metal element of the first ferromagnetic layer; and

a nonmagnetic underlayer or a nonmagnetic protecting layer disposed in contact with the magnetoresistance effect-improving layer so that the magnetoresistance effect-improving

layer is disposed between the first ferromagnetic layer and the nonmagnetic underlayer or the nonmagnetic protecting layer.

Claim 39 (Withdrawn): A magnetic storage system, comprising:

a recording/reproducing magnetic head including a substrate, a lower magnetic shield layer formed on a main surface of the substrate, and a magnetoresistance effect element formed on the lower magnetic shield layer,

wherein the magnetoresistance effect element includes a magnetoresistance effect film having a nonmagnetic spacer layer, and first and second ferromagnetic layers separated by the nonmagnetic spacer layer, a magnetization direction of the first ferromagnetic layer being at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the second ferromagnetic layer comprising first and second ferromagnetic films antiferromagnetically coupled to one another and an antiferromagnetically coupling film located between and in contact with the first and second ferromagnetic films for coupling the first and second ferromagnetic films together antiferromagnetically so that their magnetizations are aligned antiparallel with one another and remain antiparallel in the presence of an applied magnetic field, the magnetization of the first ferromagnetic layer freely rotating in a magnetic field signal, and

wherein the recording/reproducing magnetic head further includes,

a pair of electrodes coupled to the magnetoresistance effect film and having respective inner edges; and

a pair of longitudinal biasing layers for providing bias magnetic fields to the first ferromagnetic layer in parallel with a longitudinal direction of the first ferromagnetic layer and having respective inner edges, said inner edges of the pair of electrodes being disposed between the inner edges of the pair of longitudinal biasing layers.

Claim 40 (Withdrawn): A magnetic storage system, comprising:

a recording/reproducing magnetic head including a substrate, a lower magnetic shield layer formed on a main surface of the substrate, and a magnetoresistance effect element formed on the lower magnetic shield layer,

wherein the magnetoresistance effect element includes,

a nonmagnetic spacer layer;

first and second ferromagnetic layers separated by the nonmagnetic spacer layer, the first ferromagnetic layer having a magnetization direction at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the magnetization of the first ferromagnetic layer freely rotating in a magnetic field signal, a magnetoresistance effect-improving layer comprising a plurality of metal films and disposed in contact with the first ferromagnetic layer so that the first ferromagnetic layer is disposed between the nonmagnetic spacer layer and the magnetoresistance effect-improving layer, one of the plurality of metal films disposed in contact with the first ferromagnetic layer contains a metal element of not solid solution with a metal element of the first ferromagnetic layer; and

a nonmagnetic underlayer or a nonmagnetic protecting layer disposed in contact with the magnetoresistance effect-improving layer so that the magnetoresistance effect-improving layer is disposed between the first ferromagnetic layer and the nonmagnetic underlayer or the nonmagnetic protecting layer.

Claim 41 (Currently Amended): A magnetic storage system, comprising:

a recording/reproducing magnetic head including a substrate, a lower magnetic shield layer formed on a main surface of the substrate, and a magnetoresistance effect element formed on the lower magnetic shield layer,

wherein the magnetoresistance effect element includes, a nonmagnetic spacer layer;

first and second ferromagnetic layers separated by the nonmagnetic spacer layer, the

first ferromagnetic layer having a magnetization direction at an angle relative to a

magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the

second ferromagnetic layer comprising first and second ferromagnetic films

antiferromagnetically coupled to one another and an antiferromagnetically coupling film

located between and in contact with the first and second ferromagnetic films for coupling the

first and second ferromagnetic films together antiferromagnetically so that their

magnetizations are aligned antiparallel with one another and remain antiparallel in the

presence of an applied magnetic field, the magnetization of the first ferromagnetic layer

freely rotating in a magnetic field signal; and

a nonmagnetic conductivity layer disposed in contact with the first ferromagnetic

layer so that the first ferromagnetic layer is disposed between the nonmagnetic conductivity

layer and the nonmagnetic spacer layer, [[and]]

wherein the first ferromagnetic layer has a film thickness between 0.5 nanometers and

4.5 nanometers, and

the nonmagnetic spacer layer, the first ferromagnetic layer, and the second

ferromagnetic layer have a film thickness so that a bias point B.P. is in the range of 30-50%

when a product of a magnetic saturation M_s and a thickness t of the first ferromagnetic layer

is between 2 and 3 nm·T, in which,

B.P. = 50 × (Hshift / Hs) + 50, and

Hshift = -Hin + Hpin ± Hcu,

Hshift is the sum of magnetic fields applied to the first ferromagnetic layer,

Hs is an inclination of a transfer curve, Hin is a coupling magnetic field of the first

and second ferromagnetic layers via the nonmagnetic spacer layer,

Hpin is a stray magnetic field from the second ferromagnetic layer to the first ferromagnetic layer, and

Hcu is a magnetic field to be applied to the first ferromagnetic layer.

Claim 42 (Previously Presented): The magnetic storage system of claim 58, wherein an average surface roughness of an upper surface of the lower magnetic gap is smaller than a thickness of the antiferromagnetically coupling film.

Claim 43 (Currently Amended): The magnetic storage system of claim 58, wherein a distance between a center of film thickness of the first ferromagnetic film layer and one of the upper and lower magnetic shields through the nonmagnetic conductivity layer is equal or larger smaller than a distance between the center of film thickness of the first ferromagnetic [[film]] layer and another one of the upper and lower magnetic shields through the second ferromagnetic film.

Claim 44 (Currently Amended): A magnetoresistance effect element comprising:
a nonmagnetic spacer layer,
first and second ferromagnetic layer separated by the nonmagnetic spacer layer, the first ferromagnetic layer having a magnetization direction at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the second ferromagnetic layer comprising first and second ferromagnetic films antiferromagnetically coupled to one another and an antiferromagnetically coupling film located between and in contact with the first and second ferromagnetic films for coupling the first and second ferromagnetic films together antiferromagnetically so that their magnetizations are aligned antiparallel with one another and remain antiparallel in the

presence of an applied magnetic filed, the magnetization of the first ferromagnetic layer

freely rotating in a magnetic field signal, and

a nonmagnetic conductivity layer disposed in contact with the first ferromagnetic

layer so that the first ferromagnetic layer is disposed between the nonmagnetic

[[high-]]conductivity layer and the nonmagnetic spacer layer, wherein:

the first ferromagnetic layer has a film thickness between 0.5 nanometers and 4.5

nanometers, and

the nonmagnetic spacer layer, the first ferromagnetic layer, and the second

ferromagnetic layer have a film thickness so that a bias point B.P. is in the range of 30-50%

when a product of a magnetic saturation M_s and a thickness t of the first ferromagnetic layer

is between 2 and 3 nm·T, in which,

B.P. = 50 × (Hshift / Hs) + 50, and

Hshift = -Hin + Hpin ± Hcu,

Hshift is the sum of magnetic fields applied to the first ferromagnetic layer,

Hs is an inclination of a transfer curve, Hin is a coupling magnetic field of the first

and second ferromagnetic layers via the nonmagnetic spacer layer,

Hpin is a stray magnetic field from the second ferromagnetic layer to the first

ferromagnetic layer, and

Hcu is a magnetic field to be applied to the first ferromagnetic layer.

Claim 45 (Previously Presented): The magnetoresistance effect element of claim 44,

wherein the nonmagnetic conductivity layer is formed of a material having a bulk resistivity

at room temperature not larger than 10 microohm centimeter.

Claim 46 (Canceled).

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Claim 47 (Previously Presented): The magnetoresistance effect element of claim 44, wherein the first ferromagnetic layer contains CoFe alloy.

Claim 48 (Previously Presented): The magnetoresistance effect element of claim 44, wherein the nonmagnetic conductivity layer contains a metal element selected from the group consisting of Cu, Au, Ru Ir, Re, Rh, Pt, Pd, Al, Os, and Ni.

Claim 49 (Previously Presented): The magnetoresistance effect element of claim 44, wherein the nonmagnetic conductivity layer comprises a first nonmagnetic conductivity film disposed in contact with the first ferromagnetic layer and a second nonmagnetic conductivity film disposed in contact with the first nonmagnetic conductivity film so that the first nonmagnetic conductivity film is disposed between the first ferromagnetic layer and the second nonmagnetic conductivity film.

Claim 50 (Previously Presented): The magnetoresistance effect element of claim 49, wherein the first nonmagnetic conductivity film contains Cu.

Claim 51 (Previously Presented): The magnetoresistance effect element of claim 50, wherein the second nonmagnetic conductivity layer contains an element selected form the group consisting of Ru, Re, Rh, Pd, Pt, Ir, and Os.

Claim 52 (Previously Presented): The magnetoresistance effect element of claim 44, wherein:

the nonmagnetic conductive layer mainly comprises a first element,

the first ferromagnetic layer mainly comprises a second element, and

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a combination of the first element and the second element on an interface between the first ferromagnetic layer and the nonmagnetic conductivity layer does not produce a solid solution.

Claim 53 (Previously Presented): The magnetoresistance effect element of claim 44, further comprising:

an antiferromagnetic layer disposed in contact with and magnetically exchange coupled with one of the first and the second ferromagnetic films for fixing the magnetization of the one of the first and the second ferromagnetic films, the antiferromagnetic layer containing X_zMn_{1-z} in which X is an element selected from the group consisting of Ir, Ru, Rh, Pt, Pd and Re and the compositional factor z falls between 4 atomic % and 40 atomic %.

Claim 54 (Previously Presented): The magnetoresistance effect element of claim 44, further comprising:

an antiferromagnetic layer disposed in contact with and magnetically exchange coupled with one of the first and the second ferromagnetic films for fixing the magnetization of the one of the first and the second ferromagnetic films, the antiferromagnetic layer containing X_zMn_{1-z} in which X is an element selected from the group consisting of Pt and Pd and the compositional factor z falls between 40 atomic% and 65 atomic %.

Claim 55 (Currently Amended): The magnetoresistance effect element of claim 44, further comprising a layer disposed in contact with the ~~second~~ nonmagnetic conductivity layer so as to sandwich the nonmagnetic conductivity layer with the first ferromagnetic layer and containing an element selected from the group consisting of Ta, Ti, Zr, W, Hf, and Mo.

Claim 56 (Previously Presented): The magnetoresistance effect head of claim 31, further comprising:

upper and lower magnetic shields sandwiching the magnetoresistance effect element through respective ones of upper and lower magnetic gaps.

Claim 57 (Previously Presented): The magnetoresistance effect head of claim 56, further comprising a recording head that comprises:

a lower magnetic pole being common to the upper magnetic shield,

a recording gap layer disposed on the lower magnetic pole, and

an upper magnetic pole disposed on the recording gap layer.

Claim 58 (Previously Presented): The magnetic storage system of claim 41, wherein the magnetoresistance effect head further includes upper and lower magnetic shields sandwiching the magnetoresistance effect element through respective ones of upper and lower magnetic gaps.

Claim 59 (Currently Amended): A magnetic head assembly comprising:

a head slider that comprises a magnetoresistance effect head including:

a nonmagnetic spacer layer,

first and second ferromagnetic layers separated by the nonmagnetic spacer layer, the first ferromagnetic layer having a magnetization direction at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the second ferromagnetic layer comprising first and second ferromagnetic films antiferromagnetically coupled to one another and an antiferromagnetically coupling film located between and in contact with the first and second ferromagnetic films for coupling the

first and second ferromagnetic films together antiferromagnetically so that their

magnetizations are aligned antiparallel with one another and remain antiparallel in the

presence of an applied magnetic field, the magnetization of the first ferromagnetic layer

freely rotating in a magnetic field signal, and

a nonmagnetic conductivity layer disposed in contact with the first ferromagnetic

layer so that the first ferromagnetic layer is disposed between the nonmagnetic conductivity

layer and the nonmagnetic spacer layer, and

a suspension arm holding the magnetoresistance effect head, wherein:

the first ferromagnetic layer has a film thickness between 0.5 nanometers and 4.5

nanometers, and

the nonmagnetic spacer layer, the first ferromagnetic layer, and the second

ferromagnetic layer have a film thickness so that a bias point B.P. is in the range of 30-50%

when a product of a magnetic saturation M_s and a thickness t of the first ferromagnetic layer

is between 2 and 3 nm·T, in which,

$$B.P. = 50 \times (Hshift / Hs) + 50, \text{ and}$$

$$Hshift = -Hin + Hpin \pm Hcu,$$

Hshift is the sum of magnetic fields applied to the first ferromagnetic layer,

Hs is an inclination of a transfer curve, Hin is a coupling magnetic field of the first

and second ferromagnetic layers via the nonmagnetic spacer layer,

Hpin is a stray magnetic field from the second ferromagnetic layer to the first

ferromagnetic layer, and

Hcu is a magnetic field to be applied to the first ferromagnetic layer.

Claim 60 (Currently Amended): A magnetic recording apparatus comprising:

a magnetic medium,

a magnetic head assembly that comprises:

a head slider including a magnetoresistance effect head having:

a nonmagnetic spacer layer,

first and second ferromagnetic layers separated by the nonmagnetic spacer layer, the first ferromagnetic layer having a magnetization direction at an angle relative to a magnetization direction of the second ferromagnetic layer at zero applied magnetic field, the second ferromagnetic layer comprising first and second ferromagnetic films antiferromagnetically coupled to one another and an antiferromagnetically coupling film located between and in contact with the first and second ferromagnetic films for coupling the first and second ferromagnetic films together antiferromagnetically so that their magnetizations are aligned antiparallel with one another and remain antiparallel in the presence of an applied magnetic field, the magnetization of the first ferromagnetic layer freely rotating in a magnetic field signal, and

a nonmagnetic conductivity layer disposed in contact with the first ferromagnetic layer so that the first ferromagnetic layer is disposed between the nonmagnetic conductivity layer and the nonmagnetic spacer layer, and

a suspension arm holding the magnetoresistance effect head, wherein:

the first ferromagnetic layer has a film thickness between 0.5 nanometers and 4.5 nanometers, and

the nonmagnetic spacer layer, the first ferromagnetic layer, and the second ferromagnetic layer have a film thickness so that a bias point B.P. is in the range of 30-50% when a product of a magnetic saturation M_s and a thickness t of the first ferromagnetic layer is between 2 and 3 nm·T, in which,

B.P. = 50 × (Hshift / Hs) + 50, and

Hshift = -Hin + Hpin ± Hcu,

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Hshift is the sum of magnetic fields applied to the first ferromagnetic layer,

Hs is an inclination of a transfer curve, Hin is a coupling magnetic field of the first

and second ferromagnetic layers via the nonmagnetic spacer layer,

Hpin is a stray magnetic field from the second ferromagnetic layer to the first

ferromagnetic layer, and ·

Hcu is a magnetic field to be applied to the first ferromagnetic layer.